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A Delicate Method of Detecting Illuminating Gas in a Greenhouse

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A Delicate Method of Detecting Illuminating Gas in a Greenhouse

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ADVICE TO GROWERS

IF there are gas mains in the immediate vicinity of your greenhouses, be on guard for gas injury every Fall or Winter, especially after a frozen crust forms over the ground and the ventilators are kept closed most of the time. Watch and test the houses closest to the mains. For these tests keep vigorous Tomato plants growing in the warmest house distant from the mains. From time to time transfer some of these plants to the houses closest to the mains. In presence of illuminating gas the Tomato leaves turn downward as shown in the accompanying picture. (Fig. III). This is a sure way to catch the gas injury in its earliest stages and avoid years of losses.

If you suspect gas injury, act immediately by putting Tomato plants into the houses where injury occurs, or call an expert to make the tests. Do not wait for days or weeks after the injury occurs and the mains are repaired, for it is then too late to prove the presence or absence of gas in the house at the time of the injury. If for some unknown reason a greenhouse is giving poor results test for gas and establish or eliminate it as the cause of the injury. Remember that the Tomato plant is about 200 times as sensitive as the human nose in detecting illuminating gas, about 60 to 100 times as sensitive as the canary and fully 50 times as sensitive as the best chemical test. In building new greenhouses select a location that is distant from gas mains and is likely to remain so.

ILLUMINATING gas occasionally, or perhaps frequently, causes injury to plants in commercial greenhouses. There may be some greenhouse systems into which gas is actually piped and injury results from leaks from the pipes or outlets from pipes. No greenhouse system should ever have any gas piped into it and if such pipes exist they should be removed. The common source of injury is from corroded or leaky gas pipes outside the greenhouse. These injuries almost always occur in the late Fall and Winter when there is a frozen crust on the ground and the ventilators of the greenhouses are kept closed. The frozen crust prevents the gas from diffusing upward and out of the ground so the gas moves horizontally under the crust and rises where it reaches unfrozen ground. This is often in a greenhouse. The closed ventilators hold the gas in the house and in contact with the plants. The looser the soil, the greater the distance the gas is likely to diffiuse under the frozen crust to escape from unfrozen ground in a greenhouse, cave or cellar. George Stone of Massachusetts records a case of gas diffusing 2000ft. in a gravelly soil under a frozen crust and escaping into a cellar.

Weak Gas Concentrations Capable of Injury

Injury to plants in a greenhouse may continue for several years before the source of the injury is located. This is due to the fact that the very small concentration of gas necessary for injury is far below the concentration necessary for detection by odor. With illuminating gas that runs about 33 to 34 per cent carbon

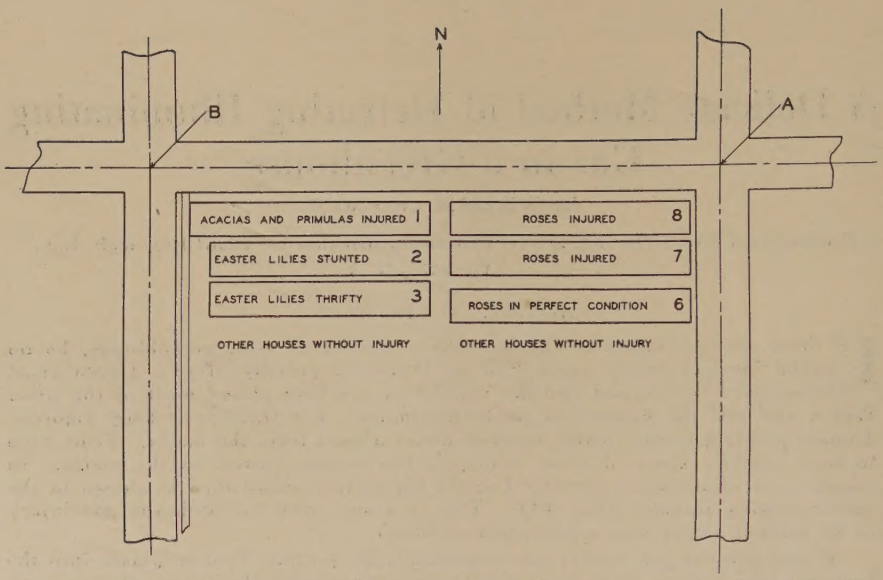

Fig. 1.—Diagram of the greenhouses, streets and gas mains in the case of gas injury described in this article.

monoxide and 9 to 10 per cent illuminants, one part in 350 of air will give a man a headache after two hours, due to the carbon monoxide present, while one part of illuminating gas in 10,000 to 100,000 of air will injure many of the more sensitive plants, due to the ethylene constituent of the illuminants. The canary is often used for detecting the presence of small concentrations of illuminating gas or other gases that contain carbon monoxide, but it is useless for a greenhouse test as the canary is not prostrated until the gas reaches 25 to 200 times the lowest concentration necessary to injure the more sensitive plants. The most delicate chemical tests used by gas companies or chemists are also too crude for detecting the least injurious concentrations for plants.

Twenty-one years ago, Doctor Lee I. Knight and I learned that one part of illuminating gas to 80,000 of air will cause freshly opened Carnations to close or "go to sleep" within a day, while one part of gas to 20,000 or 40,000 of air will stop the growth of buds of Carnations. We realized then that the detection of the smallest injurious concentration of gas to plants would probably depend upon some very sensitive plant that gave a typical response to illuminating gas. Of the dozen or two such test plants that my students and I worked out at the University of Chicago none is better for practical greenhouse work than a vigorously growing young Tomato plant, 5in. to 8in. in height. The sensitiveness and the nature of the response of the Tomato to gas was first discovered by Doubt in 1917.

A Recent Instance of Gas Injury

I could not illustrate better the injury produced by illuminating gas and the best way of establishing the source of the injury than by a case recently met in a range of commercial greenhouses. I was called to the range on Feb. 6, 1929, the injury having been first noticed on the morning of that date. The accompanying diagram (Fig. I) shows the location of the greenhouses in relation to the streets and the gas mains. The entire lines show the boundaries of the streets and the broken lines

the location of the gas mains. A shows the location of an excavation of the gas main with a leak; B is a second excavation of the main with no leak present. The line A to B was finally cut off and the mains plugged at each end.

When I arrived at the range on the morning of Feb. 6 I found the Roses in house 8, which were just coming into leaf, already shedding their leaves very freely. The Roses in house 7 had their leaves turned back stiff as shown in picture 2 of Fig. II. Roses in house 6 had their leaves well expanded and appearing normal as shown in picture 1 of Fig. II. In house 7 the Vincas shed their leaves with the least jar while those in house 6 were normal. Ageratums in house 7 had their leaves turned backward by more rapid growth on the upper side of the petiole. Acacias in house 1 shed their leaves and flower buds when the plants were jarred.

The foliage of the Primulas in house 1 appeared normal and healthy, but the flowers were considerably injured; many of the petals of the older flowers were discolored while the petals of the younger flowers failed to develop beyond one-fourth or one-third normal size. Houses 2 and 3 were filled with Easter Lilies. While the Lilies in the two houses were of the same age and grown under similar conditions, those in house 2 were three to four inches shorter than those in house 3, indicating that some factor was interfering with their growth.

All of the injuries and reactions mentioned above are typical of illuminating gas effects as has been shown in the past for a number of plants; leaf fall for many plants, in moderate concentrations of gas, (Mimosa, Salvia, Datura, Coleus, Hibiscus, etc.); more rapid growth on the upper side of the petiole or leaf stem which turns the leaf backward toward the stem, in very low concentrations of gas, (castor Bean Tomato, Datura, Coleus, Hibiscus, Calla, etc.); and greater injury of the flower than of the foliage (Carnation, Orchid, etc.)

While all of these facts indicate that illuminating gas was the source of the injury, more evidence was needed. Vigorously growing Tomato plants were set into the several houses on Feb. 6, and on Feb. 7, about 28 hours later, the pictures as

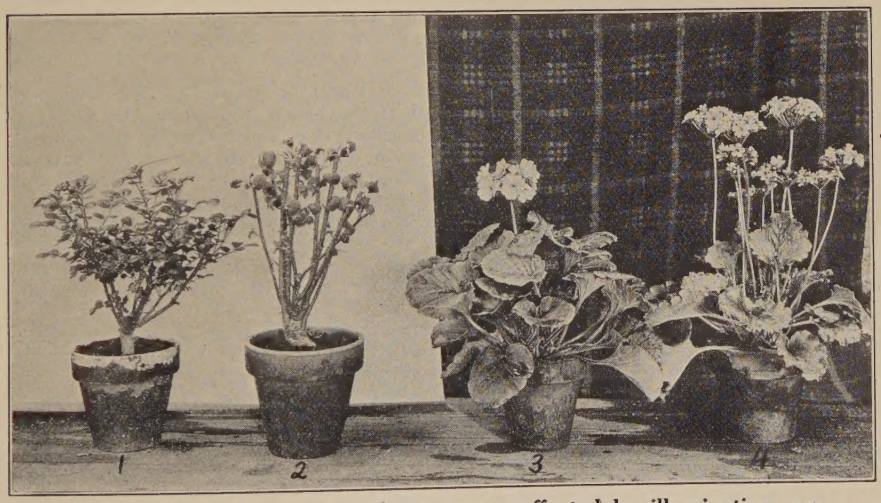

Fig. 2.—Plants from a greenhouse range affected by illuminating gas. 1 is a Rose from house 6 where no injury occurred; 2 is a Rose from house 7 where the Roses showed poor growth and the leaves were bent downward and later fell; 3 and 4 are Primulas from house 1 where marked gas injury occurred. In 4 many poorly developed petals are shown.

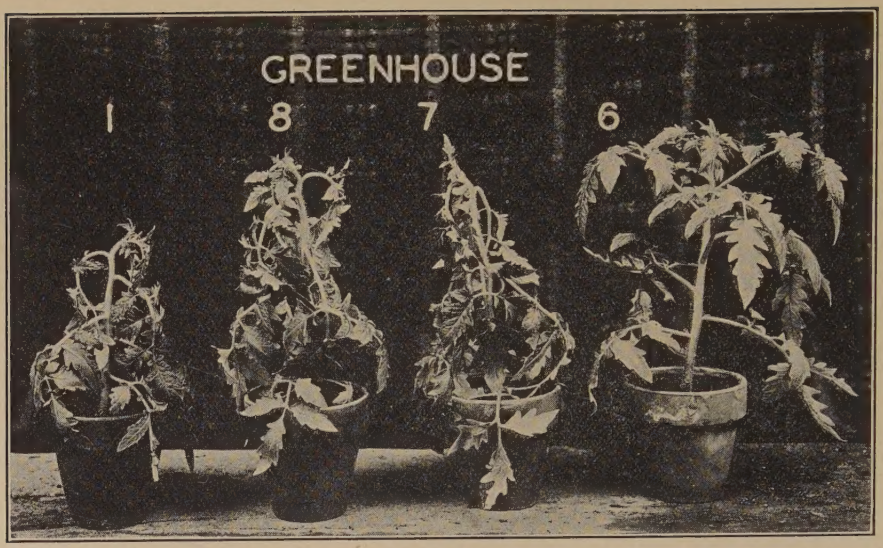

Fig. 3.—Tomato plants after being for 28 hours in different houses of the range as indicated by the numbers.

In house 1 the Acacias and Primulas were much injured; in house 8 the Roses were much injured; in 7 the Roses were noticeably injured; in 6 the Roses showed no injury. Note that the leaves of plants that were in the houses where gas injured the plants *are turned back.*

shown in Fig. III were taken. From the picture it will be noted that the leaves of the Tomatoes in houses 1, 7 and 8 are strongly turned down, indicating the presence of illuminating gas, while the Tomato from house 6 has the leaves in the normal expanded condition. This tallies up exactly with the injury in the several houses. Unfortunately, for the original test, no Tomato plants were placed in houses 2 and 3. A few days later, however, plants placed in these houses showed some gas in house 2 and none in house 3 corresponding again to the slower growth of the Easter Lilies in house 2 as compared with house 3.

Fig. IV shows freshly cut Carnations that were set in greenhouse 8 on Feb. 6 and photographed on Feb. 7, about 24 hours later. Several of the flowers have already closed or "gone to sleep."

The response of the Tomato plant to gas is a growth response, so it is desirable to have the plants in the most vigorous growth condition when they are put into the several houses as test plants. The more vigorous the growth, the quicker and the greater will be the response to gas. Since the Tomato grows best at high temperatures, the test plants should be grown in a warm greenhouse. The growing houses should also be free from gas. Practical greenhouse growers will do well to keep a number of vigorously growing potted Tomato plants in one of their warmer houses to set into any house that they may suspect has illuminating gas in it. This is a very simple and convenient way to learn whether traces of illuminating gas are present in the houses.

Precautions That Should Follow Gas Injury

After the plants in a house have been destroyed by gas one needs to be certain, even after all leaks in the main have been mended, that the gas held in the

Fig. IV.—Carnations That Had Been Placed, Freshly Cut, in House 8 and Left There 24 Hours
This house contained considerable gas; note that a number of the flowers have closed.

ground is not sufficient to still supply the house with an injurious amount of gas. This can be easily determined by placing vigorously growing Tomato plants in the house each day until they cease to show any turning back of the leaves with 24 hours exposure. When this response ceases the house can then be safely restocked and not until then. The greenhouses mentioned above were found to be free from gas on Feb. 14.

The Tomato plant is probably sufficiently sensitive to detect the smallest concentration of gas that is likely to injure greatly any of the ordinary commercial plants grown in a greenhouse. A vigorously growing Tomato plant will have its leaves turned back to a noticeable degree by concentrations of illuminating gas (with 9 to 10 per cent illuminants) as low as one part of gas in 100,000 to 200,000 of atmosphere. If a still more sensitive test plant is desired, the Castor Bean plant can be used. According to Harvey the leaves turn back as much as they do in the Tomato in concentrations of gas as low as 1 part of gas in 400,000 of atmosphere.

In most cases of supposed illuminating gas injury in greenhouses there is insufficient evidence of the actual presence or absence of illuminating gas in the greenhouse at the time the injury occurred. In such cases evidence is mainly indirect, such as the injury ceasing after the repair of mains or the nature of the injury, such as leaf fall. The Tomato plant gives a means of actually establishing the presence or absence of the gas. The Tomato plants that are used as test plants should be placed in the greenhouses as soon as gas injury is suspected and before the repair of mains. If no response occurs, no gas is present, or it is in too small a concentration to be detected, which is too small a concentration to do injury. If the response does occur, especially as marked a response as is shown in Fig. III, gas is present in sufficient concentration to do injury. In this case, the house should be tested from day to day after repair of the main to see when the houses are free from gas and ready to restock.